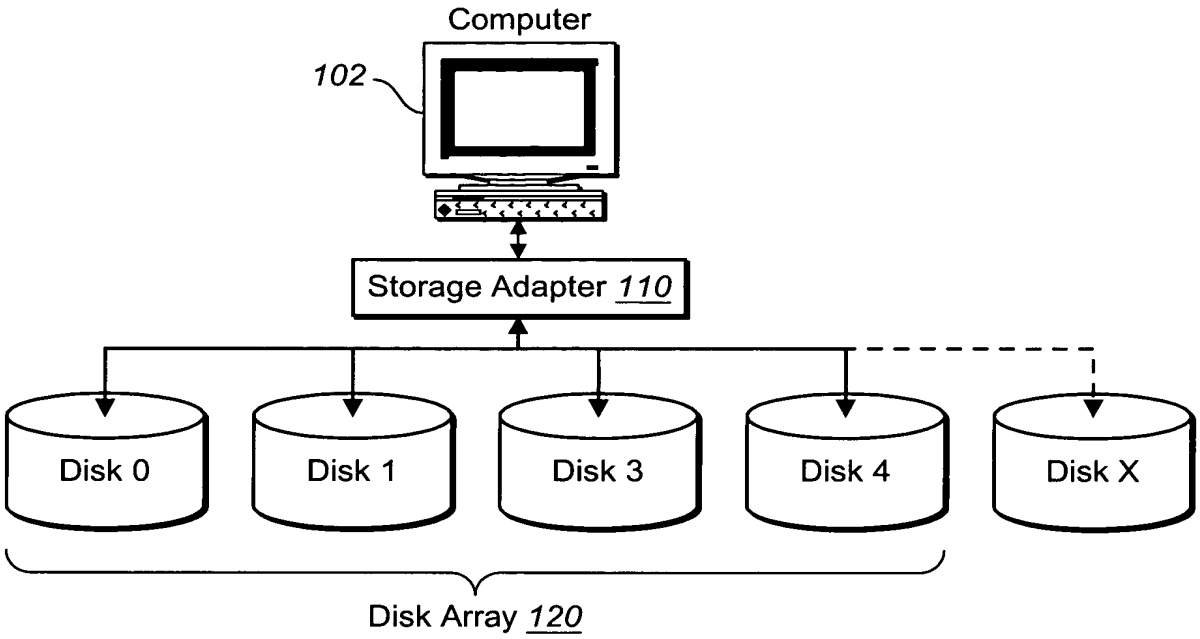
Computer
102
Storage Adapter 110
Disk 0
Disk 1
Disk 3
Disk 4
Disk X
Disk Array 120

FIG._1

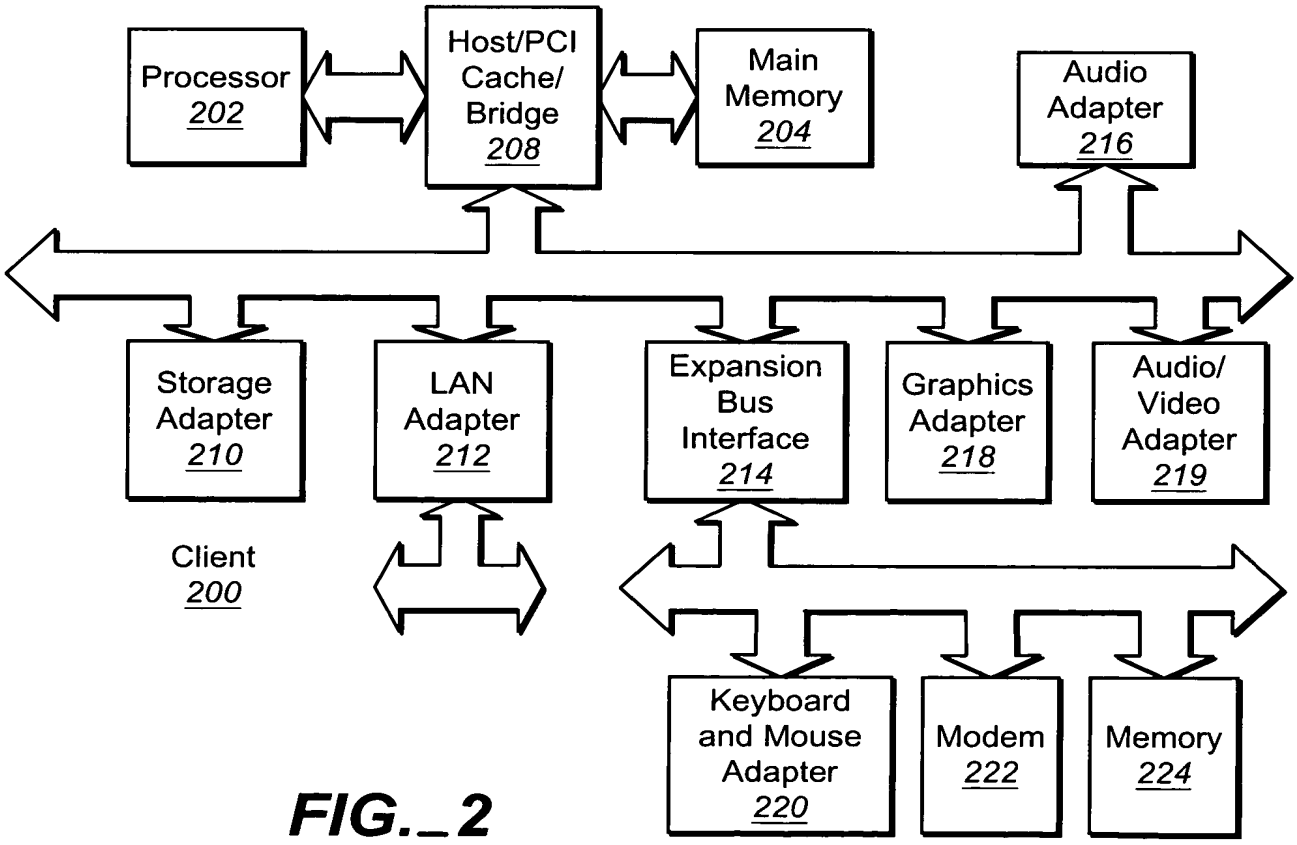
Processor 202
Host/PCI Cache/ Bridge 208
Main Memory 204
Audio Adapter 216
Storage Adapter 210
LAN Adapter 212
Expansion Bus Interface 214
Graphics Adapter 218
Audio/ Video Adapter 219
Client 200
Keyboard and Mouse Adapter 220
Modem 222
Memory 224

FIG._2

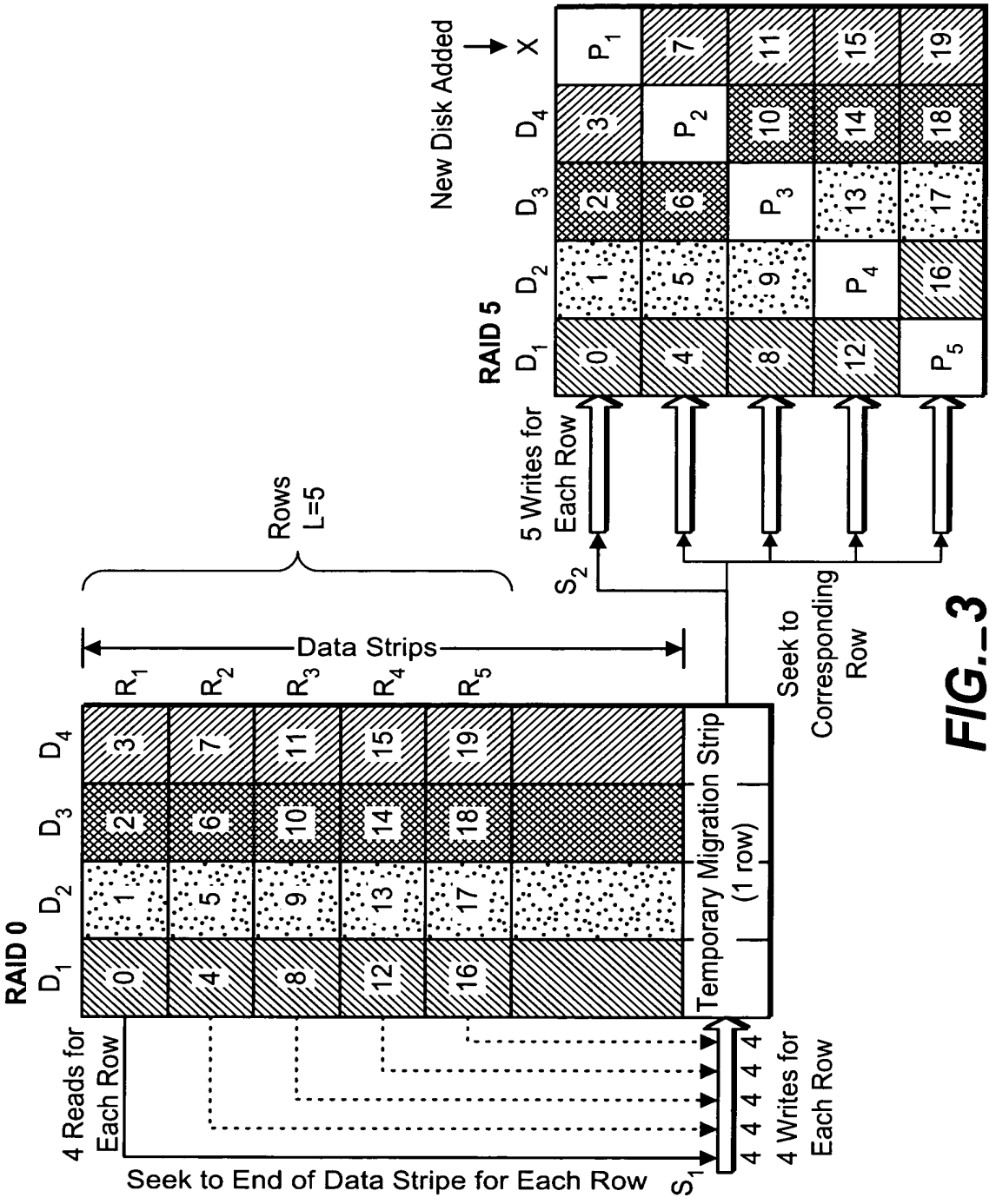

FIG._3
(PRIOR ART)

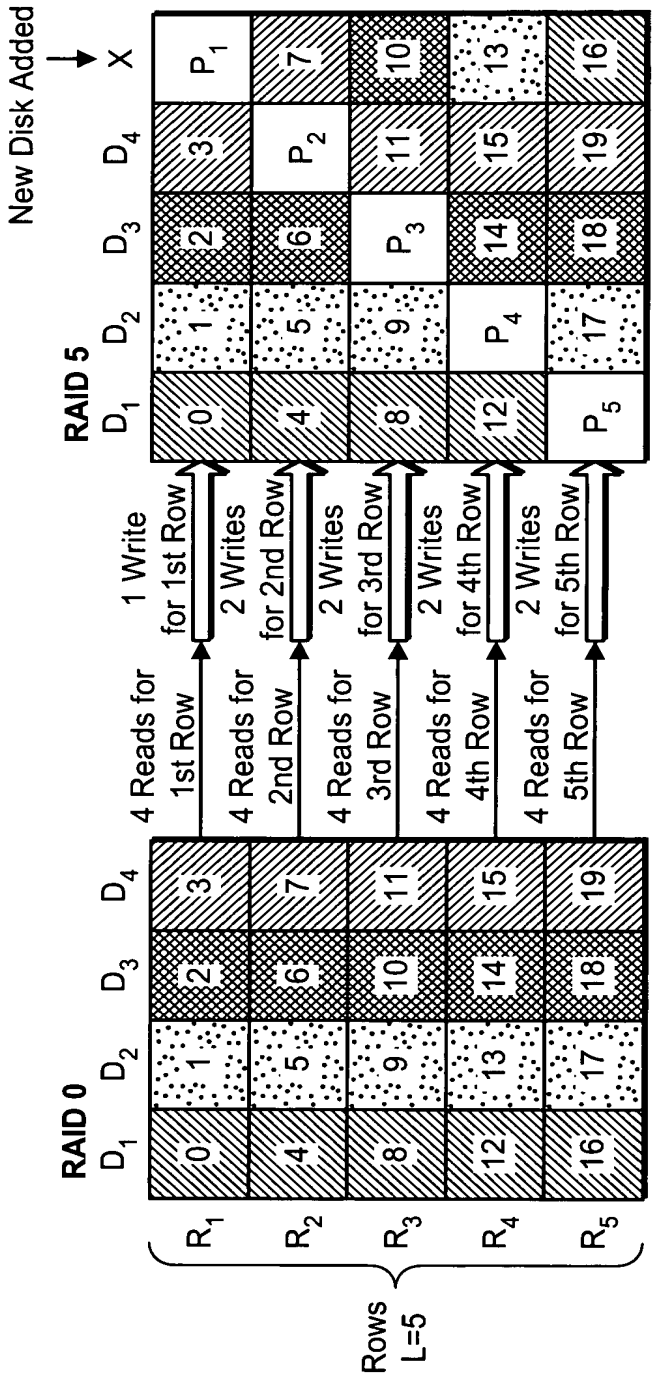
New Disk Added
X
RAID 5
RAID 0
D1
D2
D3
D4
1 Write for 1st Row
2 Writes for 2nd Row
2 Writes for 3rd Row
2 Writes for 4th Row
2 Writes for 5th Row
4 Reads for 1st Row
4 Reads for 2nd Row
4 Reads for 3rd Row
4 Reads for 4th Row
4 Reads for 5th Row
R1
R2
R3
R4
R5
Rows L=5

FIG._4

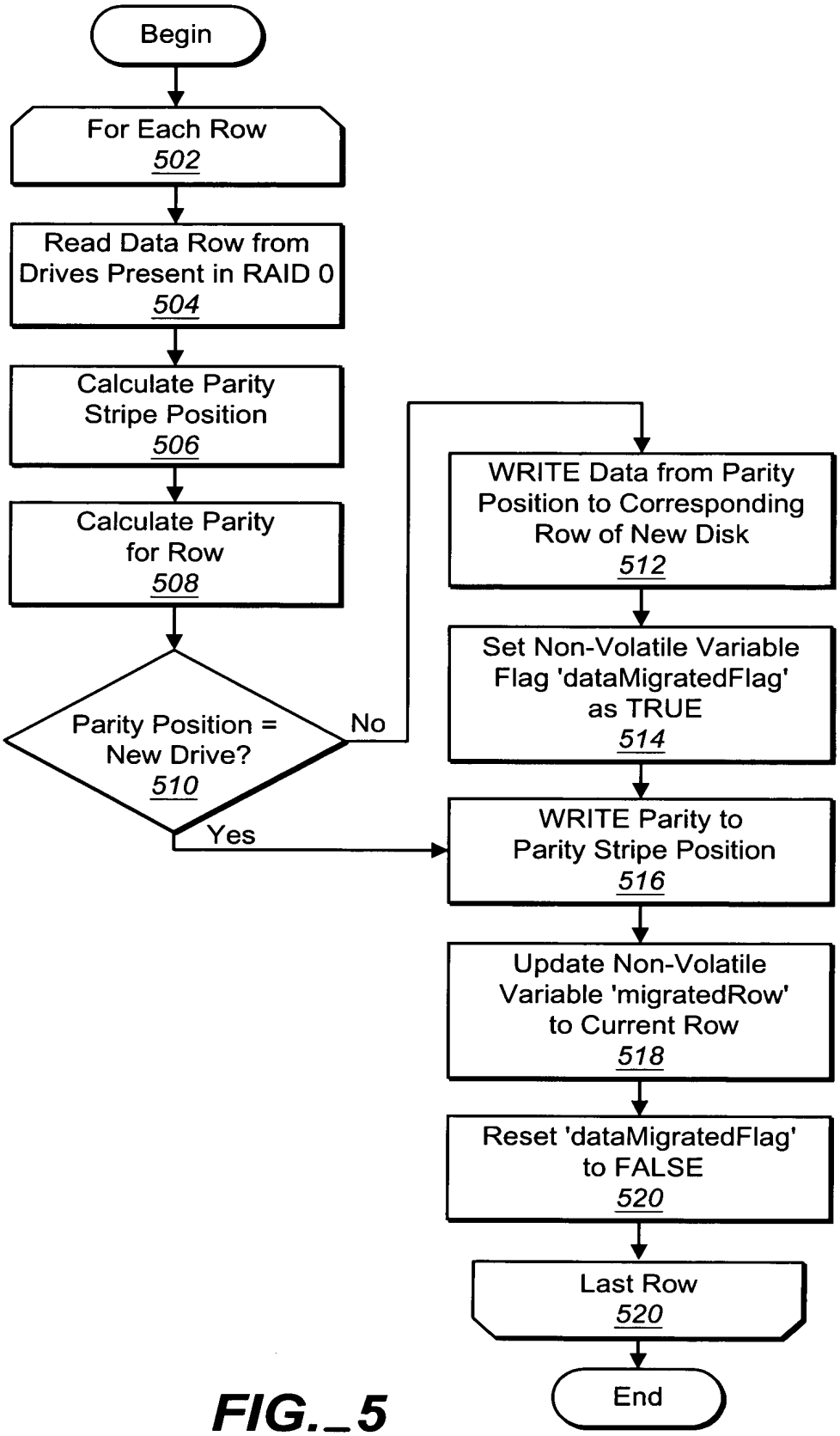
Begin
For Each Row
502
Read Data Row from Drives Present in RAID 0
504
Calculate Parity Stripe Position
506
Calculate Parity for Row
508
Parity Position = New Drive?
510
No
Yes
WRITE Data from Parity Position to Corresponding Row of New Disk
512
Set Non-Volatile Variable Flag 'dataMigratedFlag' as TRUE
514
WRITE Parity to Parity Stripe Position
516
Update Non-Volatile Variable 'migratedRow' to Current Row
518
Reset 'dataMigratedFlag' to FALSE
520
Last Row
520
End

FIG._5

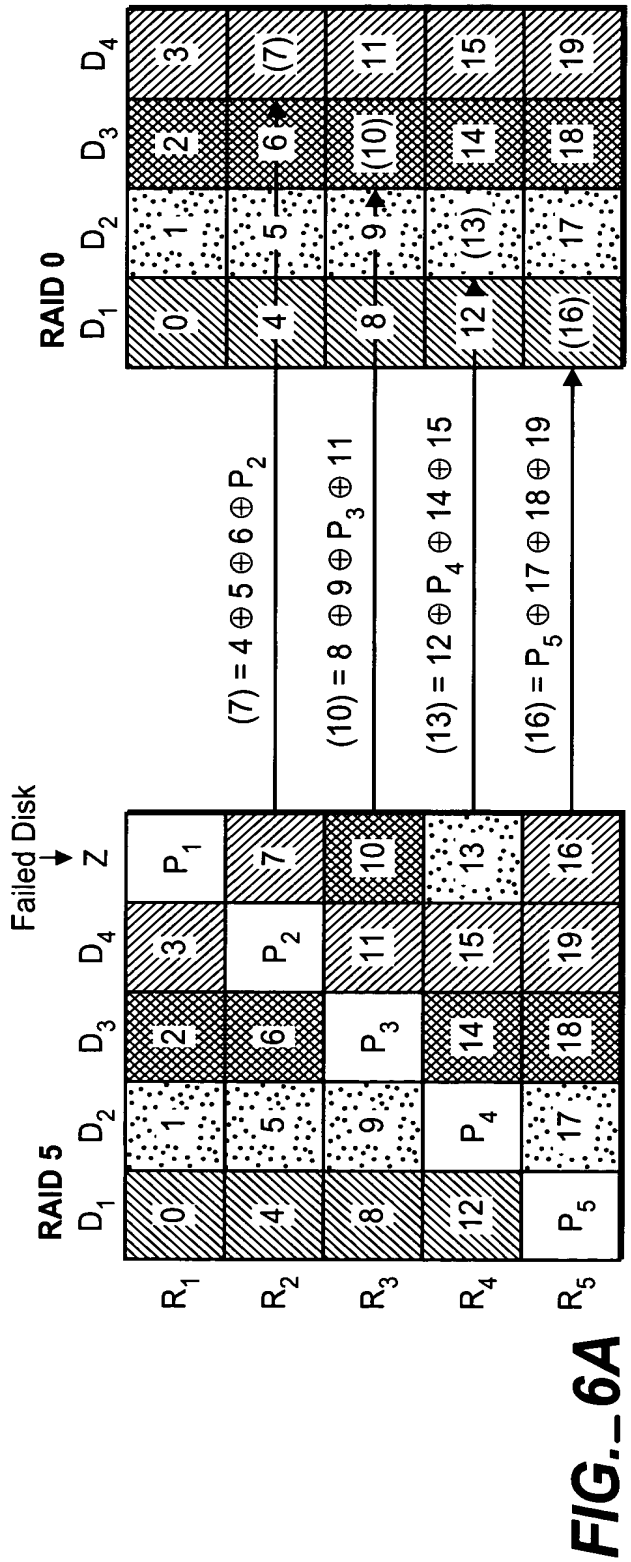
RAID 0
RAID 5
Failed Disk
(7) = 4 ⊕ 5 ⊕ 6 ⊕ P2
(10) = 8 ⊕ 9 ⊕ P3 ⊕ 11
(13) = 12 ⊕ P4 ⊕ 14 ⊕ 15
(16) = P5 ⊕ 17 ⊕ 18 ⊕ 19

FIG._6A

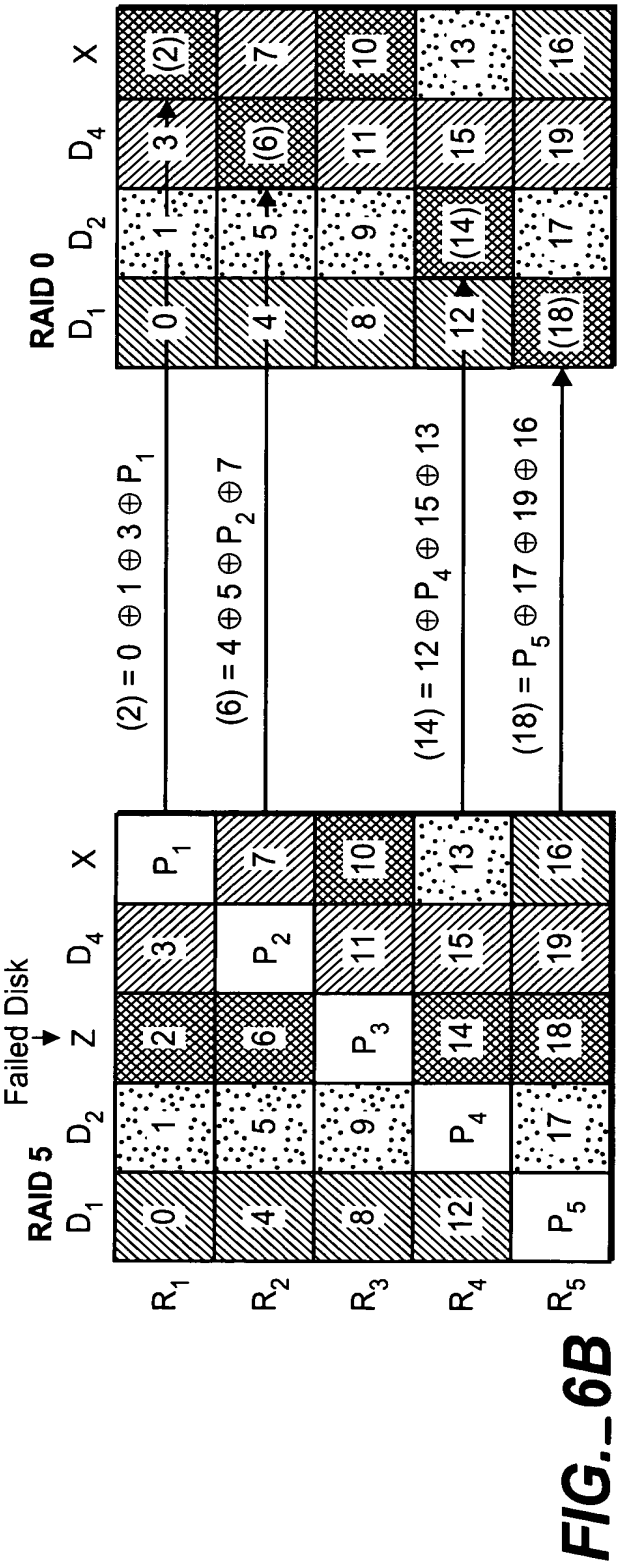
RAID 0
RAID 5
Failed Disk
(2) = 0 ⊕ 1 ⊕ 3 ⊕ P1
(6) = 4 ⊕ 5 ⊕ P2 ⊕ 7
(14) = 12 ⊕ P4 ⊕ 15 ⊕ 13
(18) = P5 ⊕ 17 ⊕ 19 ⊕ 16

FIG._6B

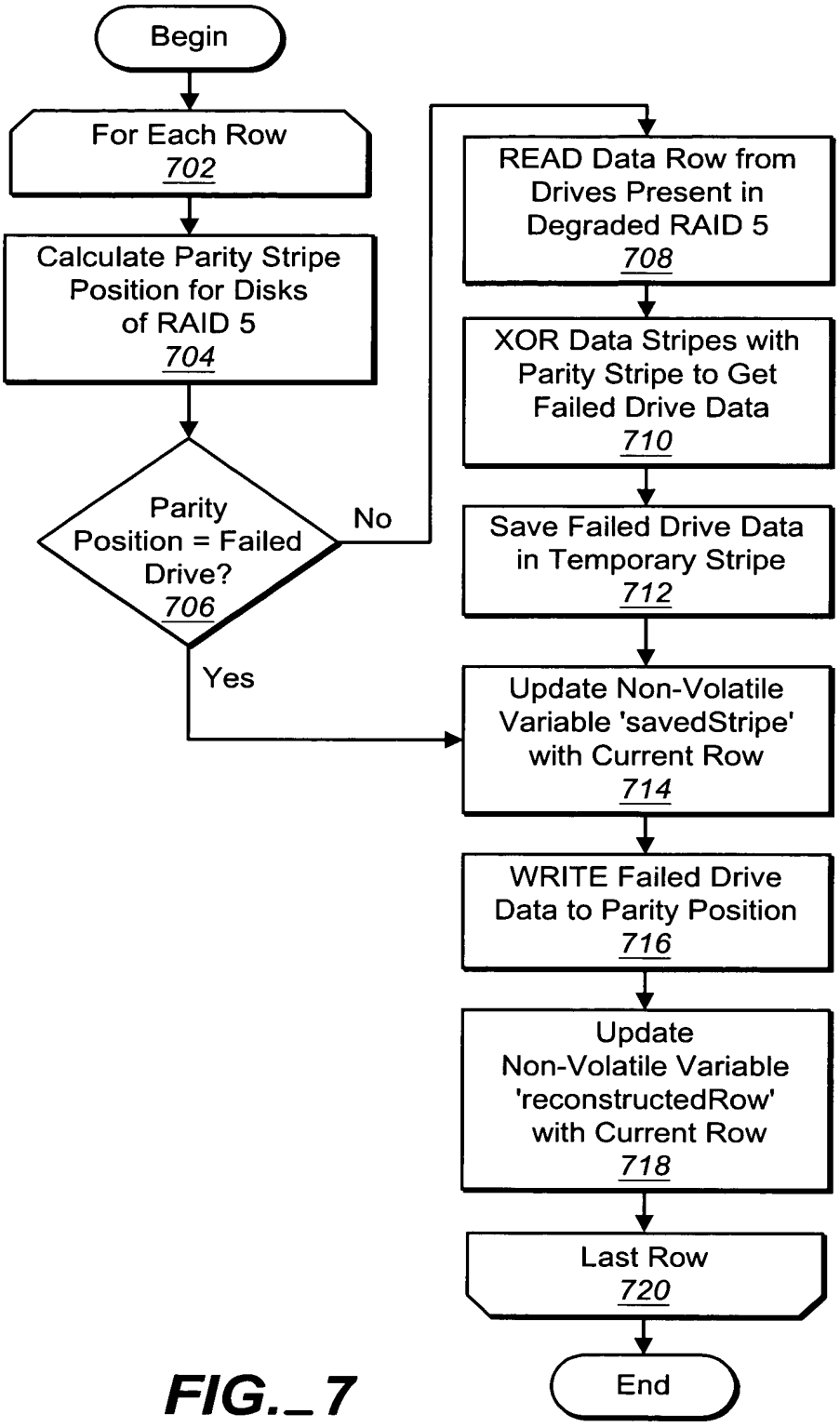
Begin
For Each Row
702
Calculate Parity Stripe Position for Disks of RAID 5
704
Parity Position = Failed Drive?
706
No
Yes
READ Data Row from Drives Present in Degraded RAID 5
708
XOR Data Stripes with Parity Stripe to Get Failed Drive Data
710
Save Failed Drive Data in Temporary Stripe
712
Update Non-Volatile Variable 'savedStripe' with Current Row
714
WRITE Failed Drive Data to Parity Position
716
Update Non-Volatile Variable 'reconstructedRow' with Current Row
718
Last Row
720
End

FIG._7

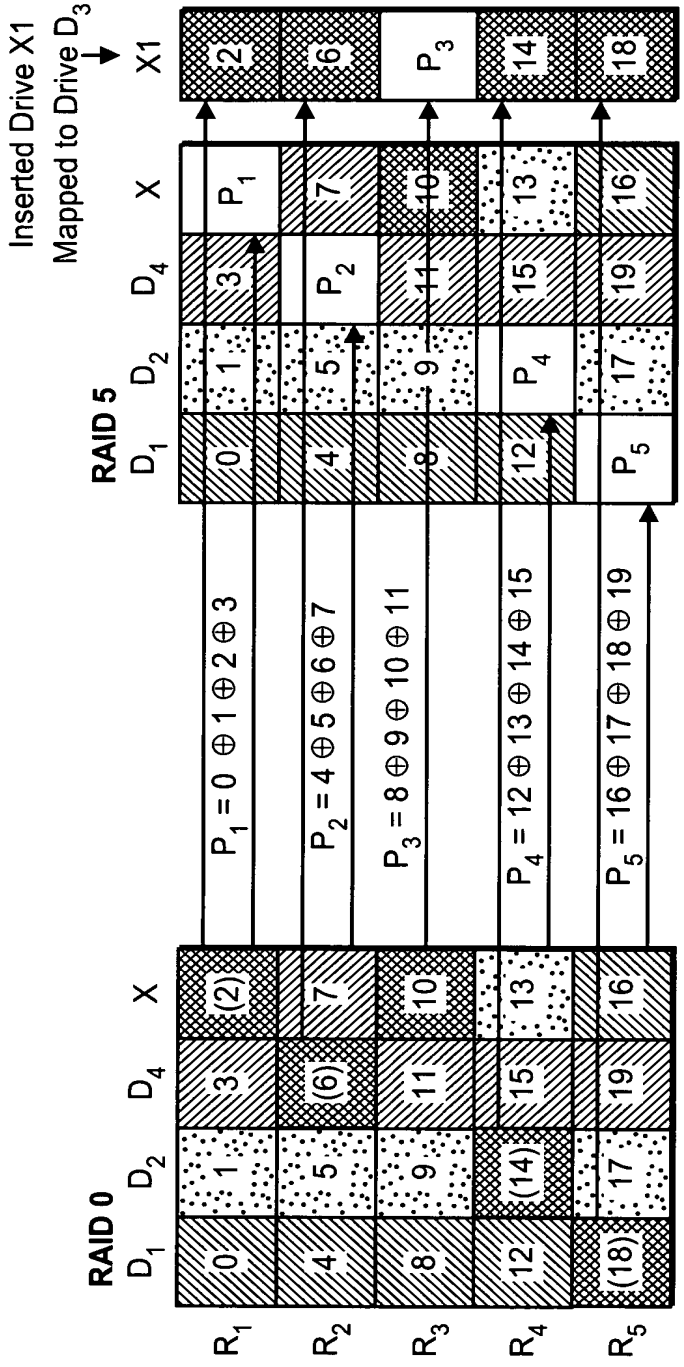
Inserted Drive X1
Mapped to Drive D3
X1
X
D4
D2
D1
RAID 5
RAID 0
R1
R2
R3
R4
R5
P1 = 0 ⊕ 1 ⊕ 2 ⊕ 3
P2 = 4 ⊕ 5 ⊕ 6 ⊕ 7
P3 = 8 ⊕ 9 ⊕ 10 ⊕ 11
P4 = 12 ⊕ 13 ⊕ 14 ⊕ 15
P5 = 16 ⊕ 17 ⊕ 18 ⊕ 19

FIG._8

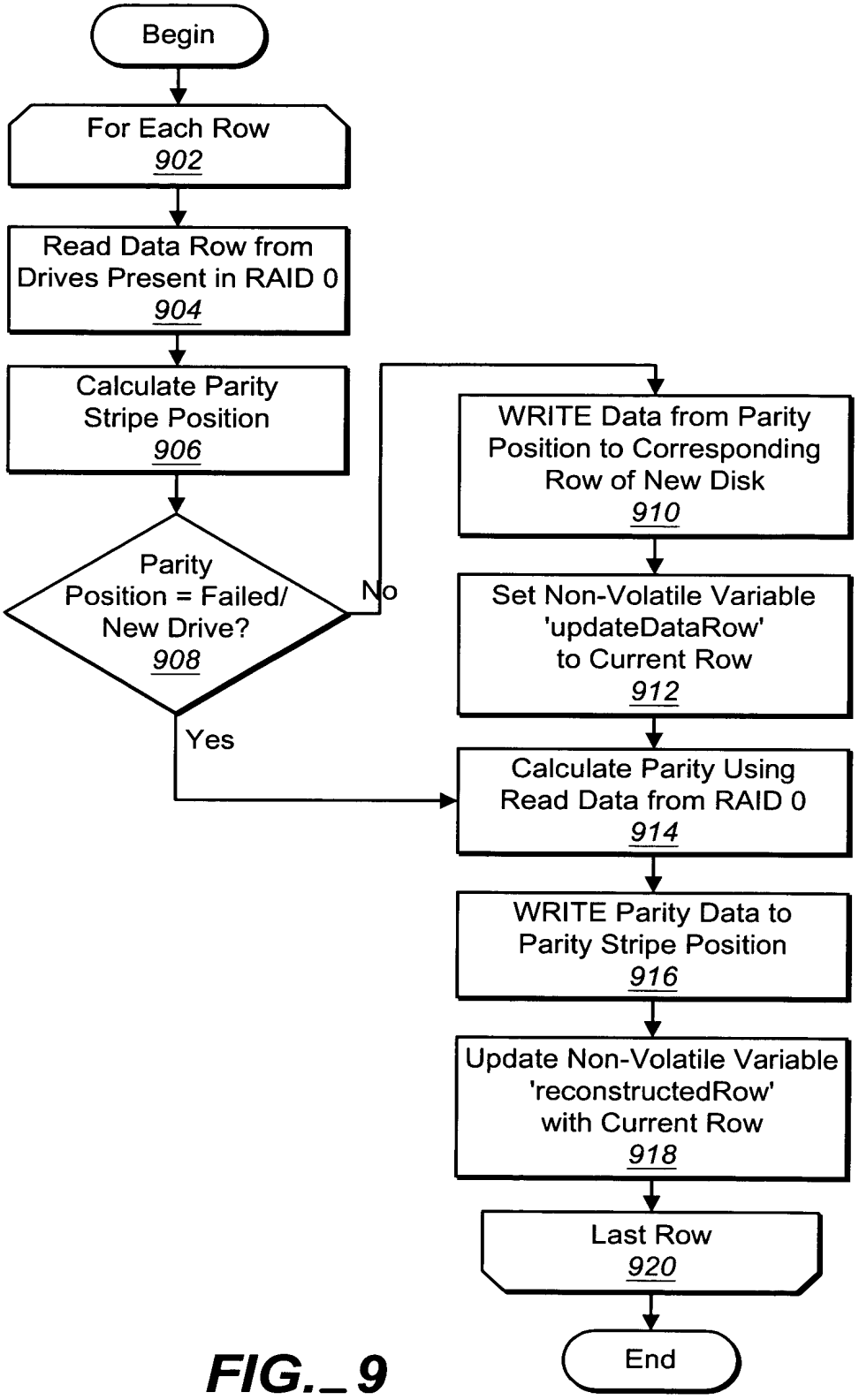
Begin
For Each Row
902
Read Data Row from Drives Present in RAID 0
904
Calculate Parity Stripe Position
906
Parity Position = Failed/ New Drive?
908
No
Yes
WRITE Data from Parity Position to Corresponding Row of New Disk
910
Set Non-Volatile Variable 'updateDataRow' to Current Row
912
Calculate Parity Using Read Data from RAID 0
914
WRITE Parity Data to Parity Stripe Position
916
Update Non-Volatile Variable 'reconstructedRow' with Current Row
918
Last Row
920
End

FIG._9

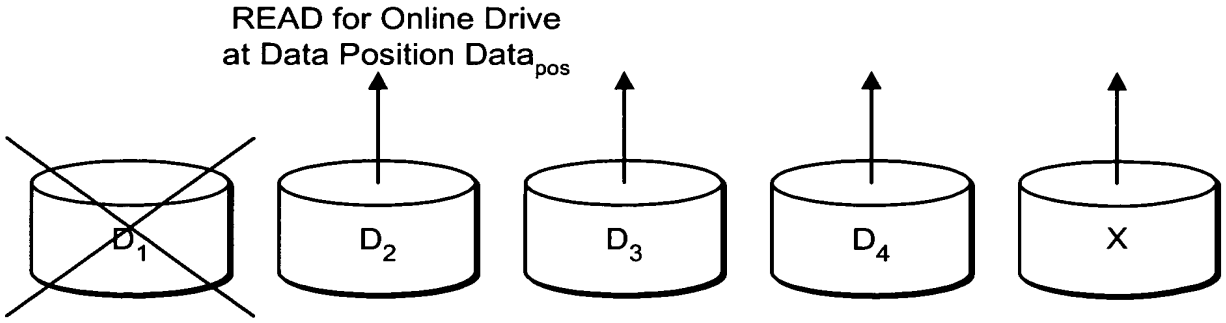

FIG._10A

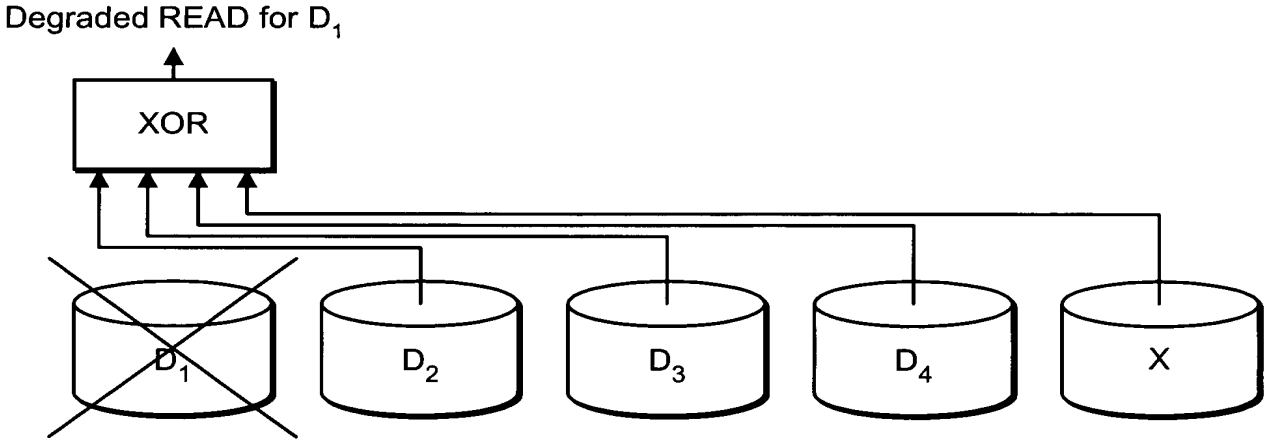

FIG._10B

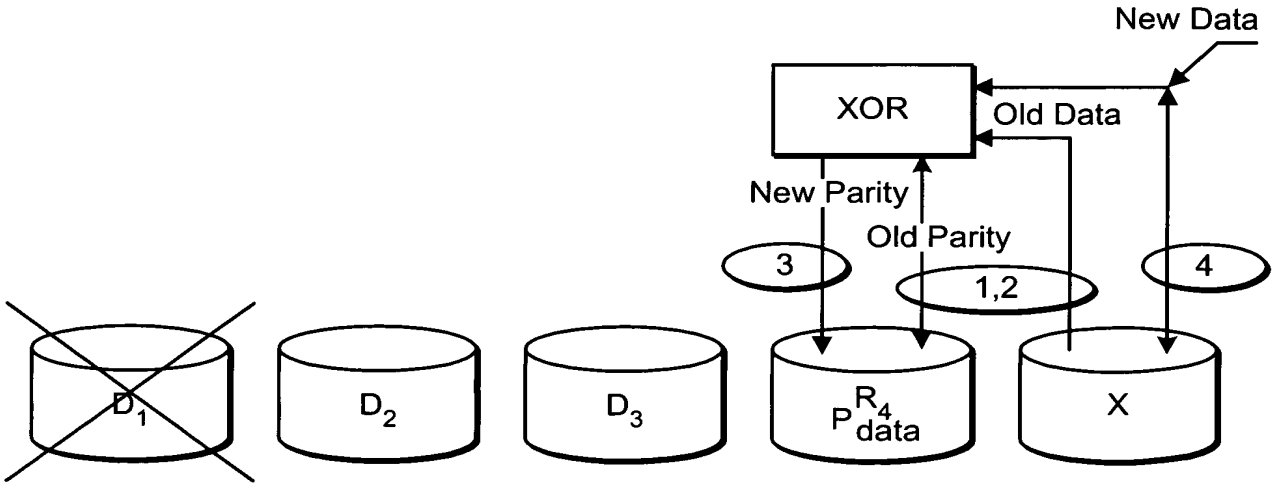

FIG._11

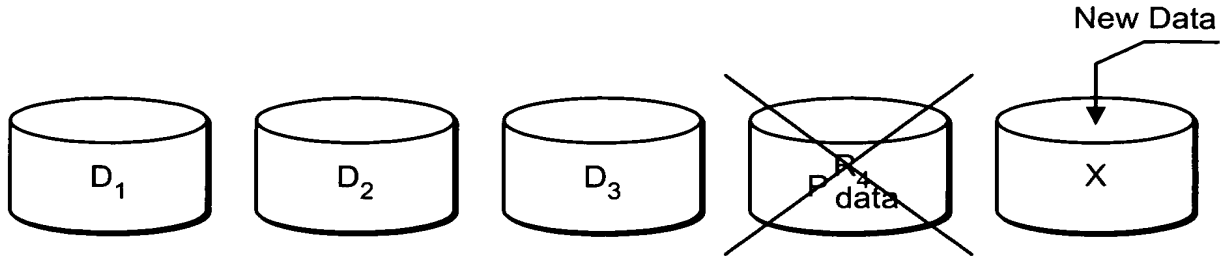
New Data
D1
D2
D3
P R4 data
X

FIG._12

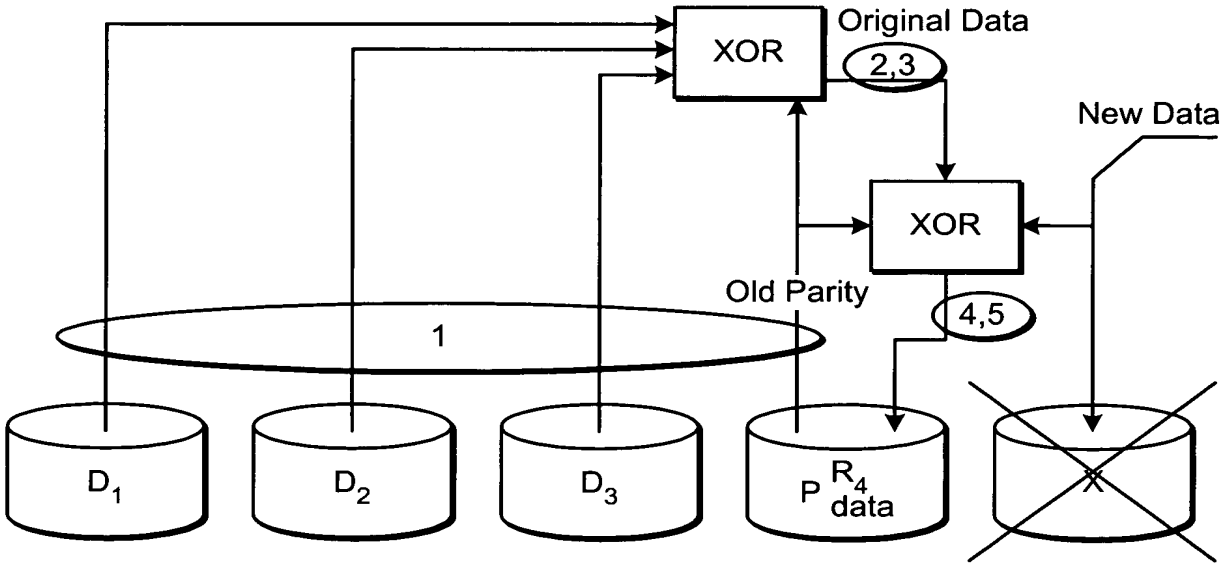
XOR
Original Data
2,3
New Data
XOR
Old Parity
4,5
1
D1
D2
D3
P R4 data
X

FIG._13

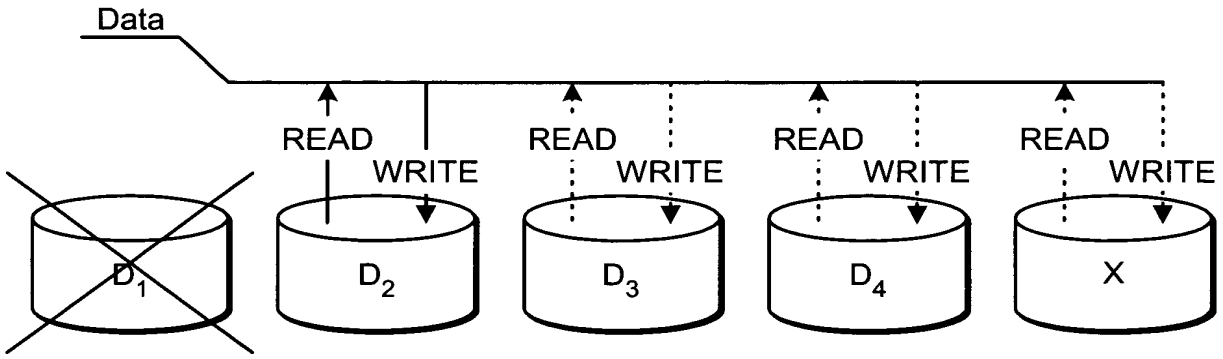

FIG._14A

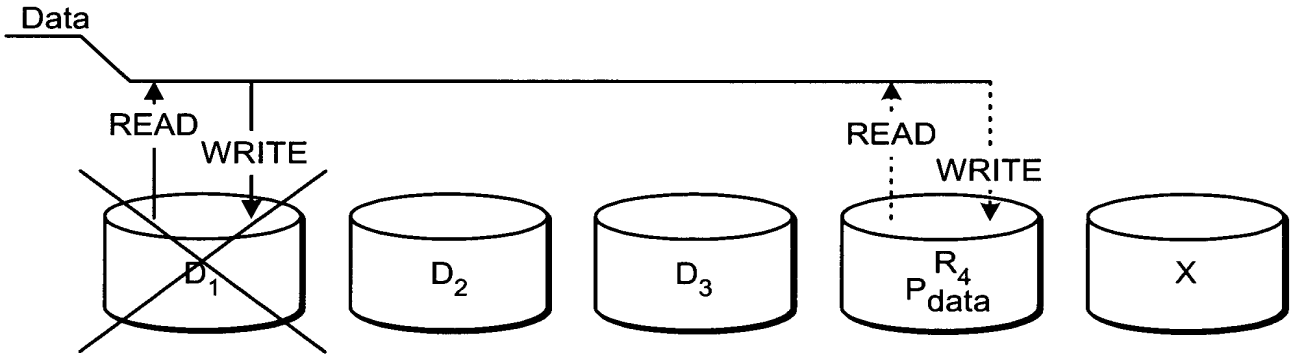

FIG._14B

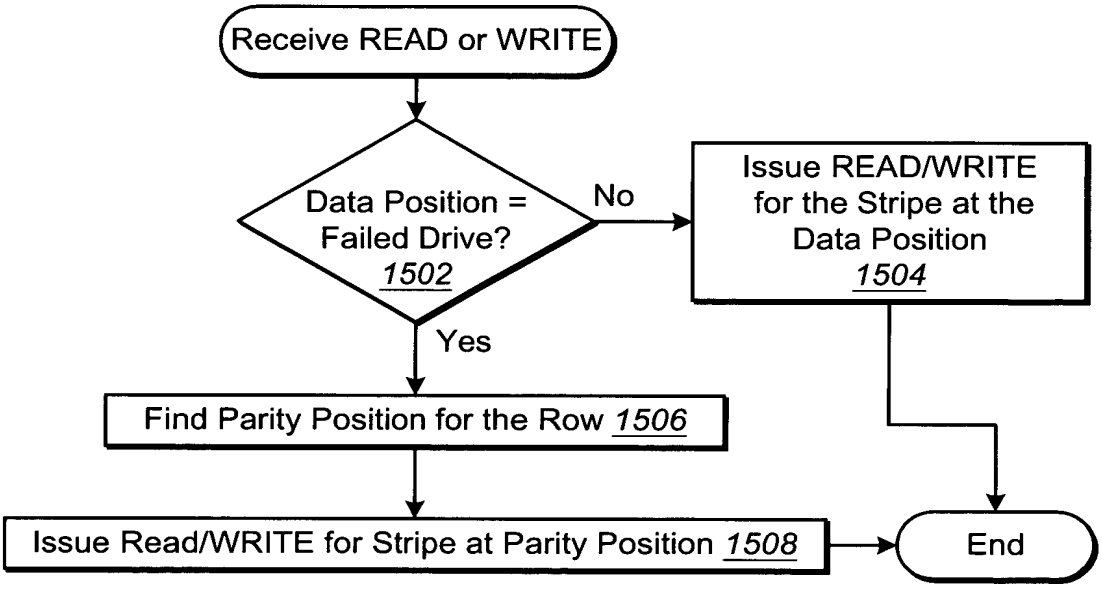
Receive READ or WRITE
Data Position = Failed Drive? 1502
No
Issue READ/WRITE for the Stripe at the Data Position 1504
Yes
Find Parity Position for the Row 1506
Issue Read/WRITE for Stripe at Parity Position 1508
End

FIG._15